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(54) A design for oil production vessels

(57) In an oil production vessel comprising a hull 40 moored by an internal turret 11 so that it may weathervane, the portion of the vessel forward of the turret contains all the areas which may normally have personnel present without external protective clothing being necessary, whereas all systems (including storage tanks) containing hydrocarbons are disposed in, or aft, or behind the turret. The vessel comprises a plurality of functional blocks 1 - 39. The design and arrangement of the functional blocks is such that they act as a structural part of the hull and provide support and separation for other functional blocks in such a way as to reduce the interfaces between the systems required to produce oil safely, economically and with minimum environmental risks.

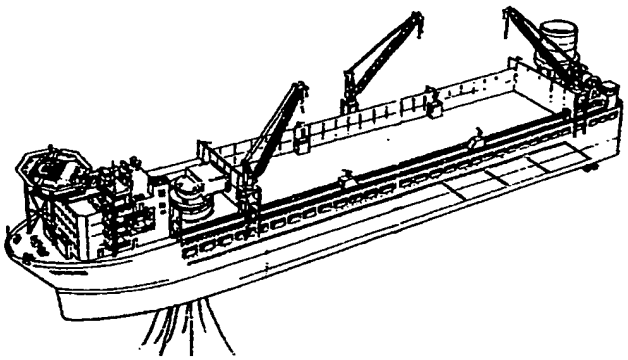

Fig. 8

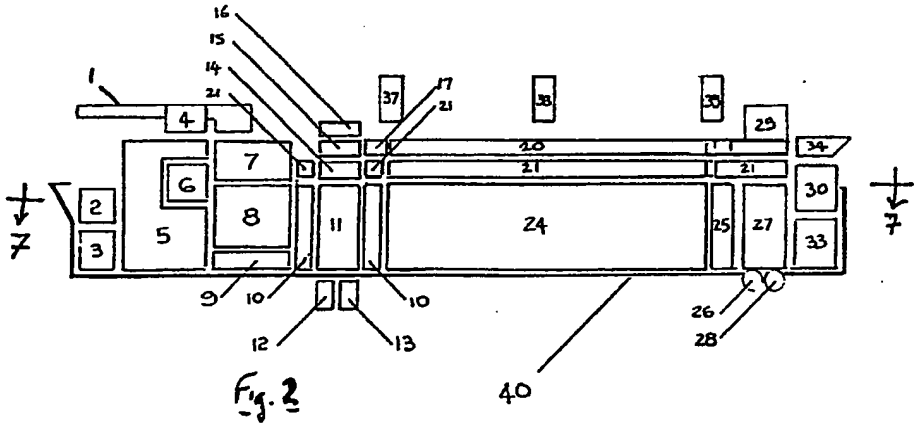

Fig. 2

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The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1990.

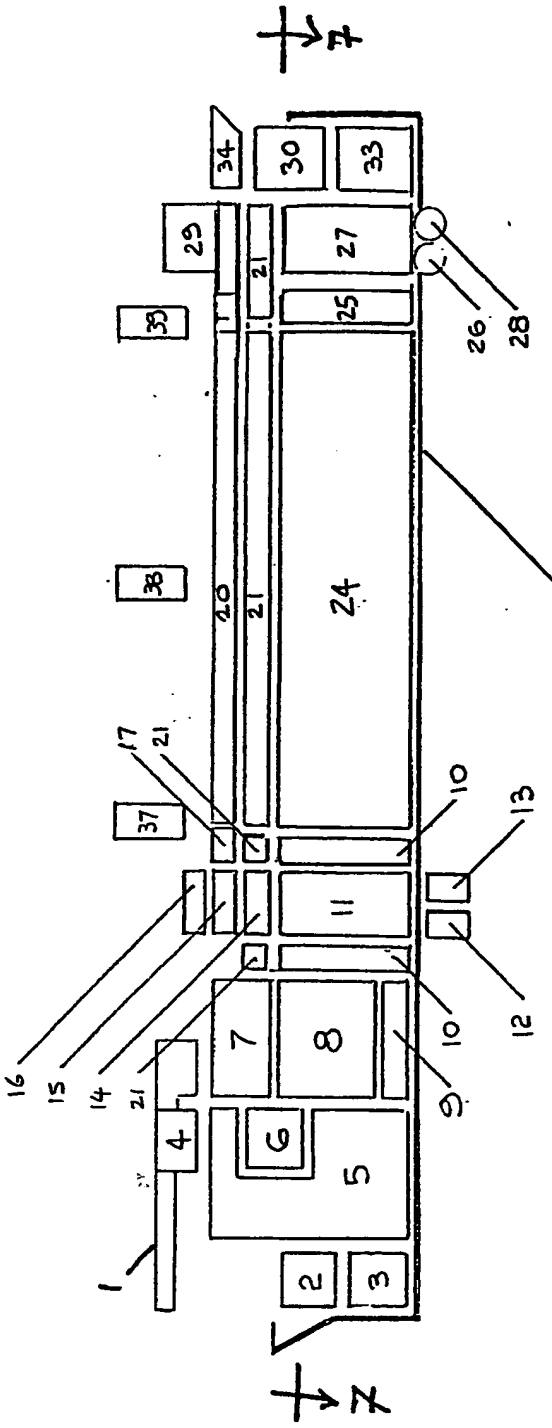
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Fig. 2

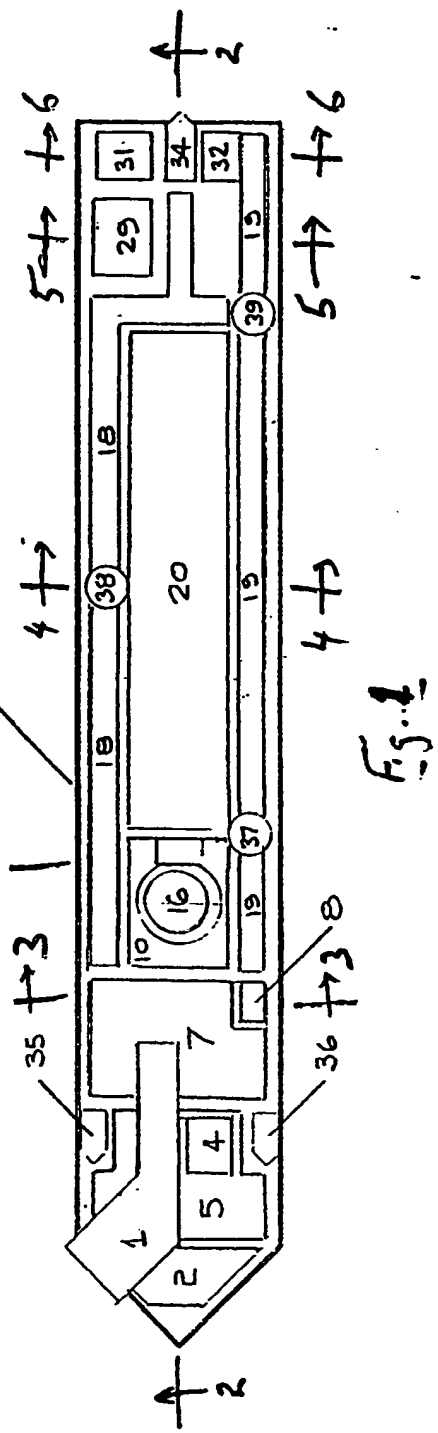
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Fig. 1

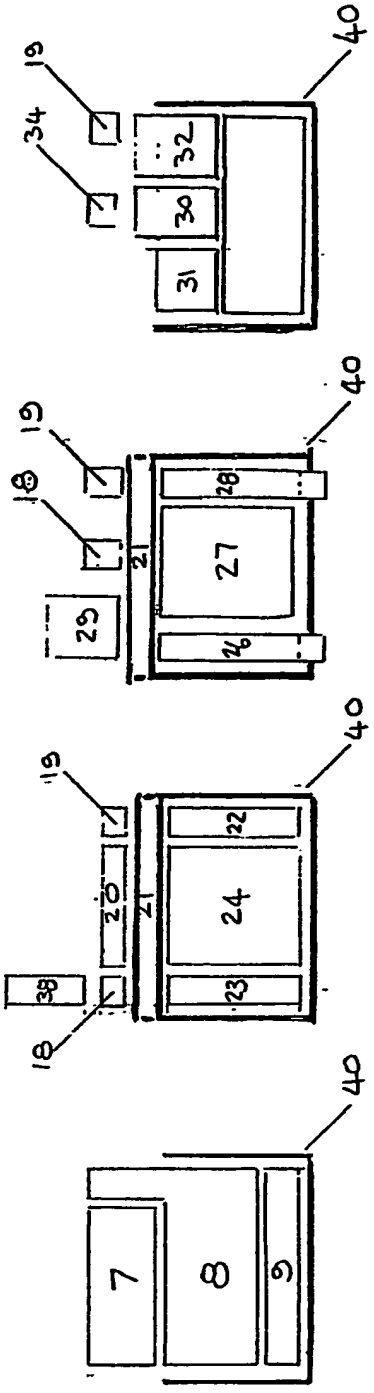

Fig. 3

Fig. 4

Fig. 5

Fig. 6

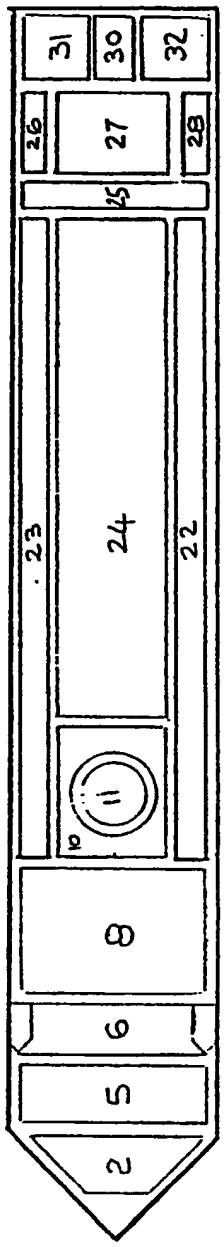

Fig. 7

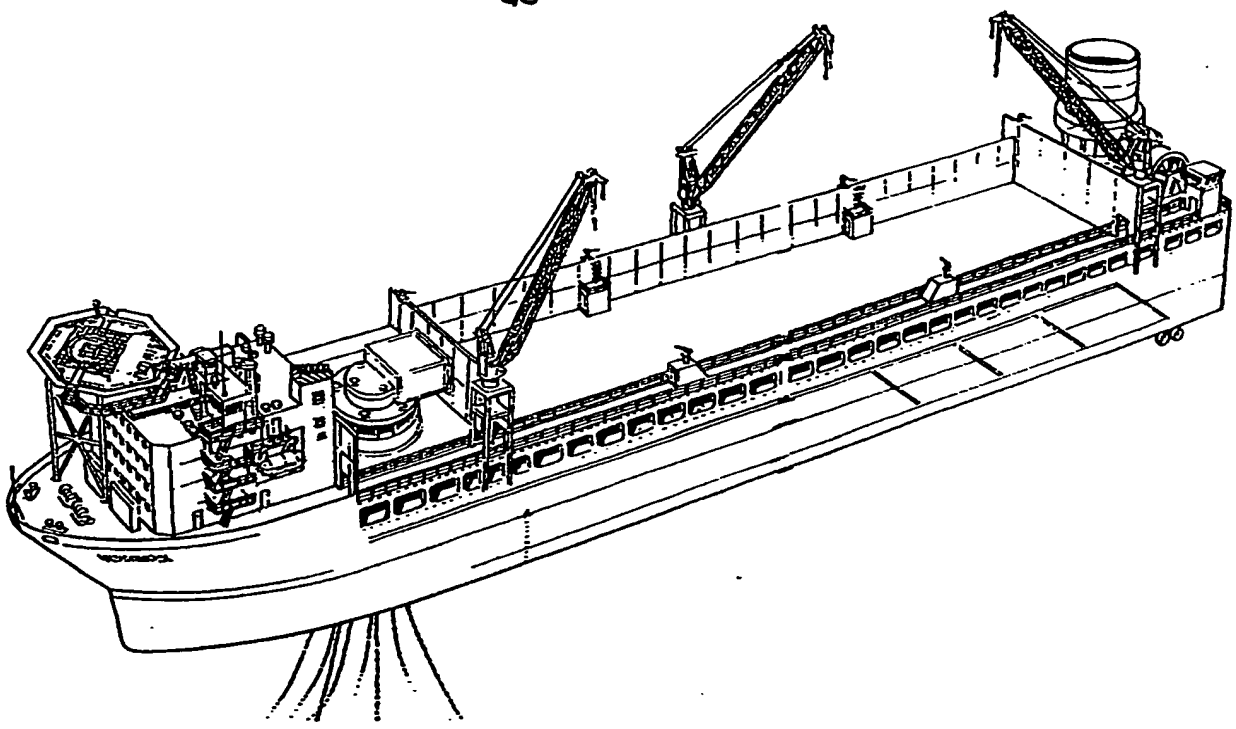

Fig. 8

A DESIGN FOR OIL PRODUCTION SHIPS

This invention relates to a vessel, ship or barge, hereinafter generically called a "vessel", and to the design of such a vessel, the vessel being for economically exploiting oilfields in the marine environment and incorporating all the facilities to connect to subsea oil wells, control, process, store and later off-load the produced oil and vent or flare or pipe away the hydrocarbon gasses, all in a safe manner which meets the relevant national and international regulations.

The building of new floating production vessels, incorporating oil storage, is becoming an increasingly important option for exploiting offshore oil fields. However, it has been difficult to identify a hull configuration which will work economically over a range of different oil field developments. An additional specific problem for the oil field operator is that he cannot easily vary the specification of the hull and systems after some parts of the vessel detailed design and construction has started, typically 18 to 24 months before first oil is produced. The changing regulatory requirements in different countries can also make existing designs quickly obsolete for many future applications. Furthermore, after the oil field has been depleted, which will usually be a period less than the life of the vessel, it will be difficult to modify a field-specific design for use on future oil fields.

According to the present invention a design method using a unique arrangement of functional blocks is provided for a range of hull sizes that offers variability of the main specification features without the need for a specific size of hull, mooring design or riser system at the initial development stages of a particular oil field. These features are incorporated in a design that offers oil storage configurations to meet all present, and anticipated, safety and pollution requirements. The invention also provides for new and novel functional blocks that will improve the design of floating production vessels in meeting national and international safety and pollution requirements.

According to the invention in one aspect there is provided a vessel comprising a hull moored by an internal turret which is forward of the centre of environmental forces near the amidships, so that the vessel may weathervane, the portion of the vessel forward of the turret containing all the enclosed and mechanically ventilated areas, which have personnel present without protective clothing being necessary, to operate the vessel in the same manner as a ship, all the systems containing hydrocarbons and hazardous area being placed in, or aft, or behind the turret.

Such an arrangement is advantageous for a number of reasons including the fact that areas that are normally occupied by crew are always upwind of the dangerous processing and

storage areas, both in the event of a fire and during normal operation.

A specific embodiment of the invention will now be described, by way of example, with the accompanying drawings, in which:-

Figure 1 shows a plan view of the vessel;

Figure 2 shows an upright section of the vessel taken along the line 2-2 of Figure 1;

Figures 3 to 6 are upright sections taken respectively along the lines 3-3, 4-4, 5-5 and 6-6 of Figure 1;

Figure 7 is a section taken along the line 7-7 of Figure 2; and

Figure 8 is a perspective view of the completed vessel.

Referring to the drawings, the vessel comprises a hull 40 which provides the flotation and stability to support all the functional blocks 1 to 39 inclusive. These functional blocks are the primary subdivision, by function, of the systems required to exploit economically, oilfields in the marine environment. These functional blocks incorporate all the facilities to connect to subsea oil wells, control,

process, store and later off-load the produced oil and vent or flare or pipe away the hydrocarbon gasses all in a safe manner which meets the relevant national and international regulations.

The functional blocks 1 to 39 are given in the following list with the names commonly used on the Marine Industry, and or, the Offshore Oil Industry. The marine convention of Forward / Aft and Port / Starboard has been used, but this should be considered to be the same Front / Back and Left / Right. The description is also to cover the case where Port can be substituted for Starboard and Starboard for Port, to produce mirror images of the arrangement(s).

1. Helicopter Facilities
2. Forward Marine Equipment
3. Forward or Peak ballast tank
4. Bridge or Pilot House
5. Hotel Services or Accommodation Block
6. Evacuation Muster Station or Safe Refuge
7. Operational Control Centre
8. Utilities Support Unit or Engine Room
9. Fuel Storage
10. Turret Housing and Forward Cofferdam
11. Mooring Turret
12. Mooring Lines or Catenary Mooring
13. Risers or Flowlines
14. Riser Termination

15. Emergency Shut Down Valves
16. Swivel Assembly or High Pressure Fluid Transfer unit(s)
17. Well Fluid Pressure Control or Choke Valves (note this may be optionally placed before or after item 15.)
18. Starboard side protected access route
19. Port side unprotected access route which may be continuous during construction, at times when the process plant is not in operation or in emergency situations, but will be sectioned off by doors at the structural barriers during normal operation
20. Process Deck
21. Main Deck Sandwich Structure which will be continuous during construction, and may have continuous access at times when the process plant is not in operation or in emergency situations, but will be sectioned off by doors at the structural barriers during normal operation
22. Port Wing Ballast and Trim Tanks
23. Starboard Wing Ballast and Trim Tanks
24. Tanks for products, oil cargo, slops or ballast where the tanks are formed by internal horizontal or vertical barriers to a number required to ensure stability and to minimize pollution in case of damage to one or more tanks,
25. Aft Cofferdam
26. Starboard Thruster System
27. Pump Room containing the pumps and valves necessary to

fill, empty and control the amount of fluids in the tanks, and which function may be supplemented by pumps contained in some of the tanks.

28. Port Thruster System
29. Gas and Oil Flare(s) and Gas Venting System(s)
30. Shuttle Tanker Mooring System
31. Aft Marine Equipment
32. Crude Oil Offloading System
33. Aft Trim and Ballast Tank
34. Aft Lifesaving Apparatus
35. Forward Starboard Lifesaving Apparatus
36. Forward Port Lifesaving Apparatus
37. Forward Port Cranage
38. Central Starboard Cranage which may be provided by one or more cranes or gantries
39. Aft Port Cranage

The interface structure between the functional blocks is so arranged to provide the strength necessary to stiffen the hull so that it may resist the environmental forces, support the functional blocks themselves and provide a barrier between the functional blocks. Thus each block is itself designed to be self supporting and complete both as to its operation and design, apart that is for necessary connections to other blocks and to utilities.

The arrangement of the functional blocks is in such a unique way as to minimise the number of interfaces between

the functional blocks that need to be penetrated by pipes, cables and operating personnel, necessary to operate the vessel.

The functional blocks are defined by the following set of rules:-

- Blocks are single structural entities inside the boundaries of the block.
- The block may share structural support with adjacent blocks.
- The structural support between blocks generally forms a barrier and some functional blocks form the barrier between other functional blocks.

Barriers can be any one or combination of:

- Gas tight
- Watertight
- Flame resistant
- Pressure resistant
- Blast resistant

- Blocks containing active Hydrocarbons are separated from other working (areas which have or may have personnel present) blocks by an impervious barrier or a non active space contained between barriers
- Non active blocks have one dimension between other active blocks which is at least the minimum dimension required to meet national and international requirements on the separation of Hazardous Areas.

These non active blocks define, but do not necessarily totally enclose, a area or volume that is either:

- Completely enclosed and ventilated in such a way as to ensure a non explosive gas mixture is present
- Completely enclosed and to be filled and emptied with water in a controlled manner, such that no explosive gas mixture may enter when the water is emptied
- Not enclosed on at least two boundaries such that the ventilation is by the free movement of fresh air

Each of these primary functional blocks may be described, specified, designed, engineered in detail and constructed within pre-defined structural boundaries which will form the necessary boundaries between the functions to meet the regulations and requirements for operating the vessel.

The invention therefore also extends to a method of designing a vessel according to these criteria and also to building a vessel according to that design and these criteria.

The invention further extends to a unique type of primary functional block shown as 21, the Main Deck Sandwich Structure. This block is a type of vessel deck which is designed to give structural strength, and act as a barrier

as defined by national and international regulations between the hydrocarbon processing equipment and the stored oil. The top and bottom of the sandwich are steel boundaries with the internal space being freely ventilated from the sides as can be seen very clearly from Figure 8. Internal girders provide the stiffening strength to enable the deck to span the cargo and ballast tanks and support the process plant above, as well as contributing to the longitudinal strength of the hull.

Therefore the invention in a further aspect comprises a vessel for storing and processing oil having a deck which provides structural strength and acts as a barrier between an oil storage area and an oil processing area positioned at least partially above the oil storage area, the deck comprising a sandwich made up of continuous metal sheeting held apart by girders which provide the stiffening strength to enable the deck to span the oil storage area and support the oil processing area, the girders having openings and at least the two opposed side edges of the deck being open to the atmosphere so that the deck is freely ventilated.

The invention also incorporates a specific arrangement of the six primary functional blocks 1, 5, 6, 7, 35 and 36 to meet the United Kingdom regulations on the evacuation of oil installations developed after the Lord Cullen report on the Piper Alpha disaster enquiry. The specific arrangement allows that the primary normally manned areas 5 and 7 are

connected and also directly interfaced:

- with 6 which is directly interfaced with the lifesaving equipment 35 and 36 and
- with 1, which is achieved by having vertical access in both 5 and 7 up to 1.

By following the design method according to the invention one can achieve a number of advantages:

1 A design method using a unique arrangement of functional blocks is provided for a range of hull sizes that offers variability of the main specification features without the need for a specific size of hull, mooring design or riser system at the initial development stages of a particular oil field. These features are incorporated in a design that offers oil storage configurations to meet all present, and anticipated, safety and pollution requirements. The invention also provides for new and novel functional blocks that will improve the design of floating production vessels in meeting national and international safety and pollution requirements.

2 The total system is subdivided into a number of single primary functional blocks and the arrangement of these blocks is in such a way that there are no divided primary functions.

3 Each of these primary functional blocks may be described, specified, designed, engineered in detail and constructed within pre-defined structural boundaries which will form the necessary boundaries between the functions to meet the regulations and requirements for operating the vessel.

4 The secondary functional connections between blocks can be categorised as a series of interface requirements.

5 The design incorporates a unique type of primary functional block the Main Deck Sandwich Structure 21. This block is a new type of vessel deck which is designed to give structural strength, and act as a barrier as defined by national and international regulations between the hydrocarbon processing equipment and the stored oil. The top and bottom of the sandwich can be steel boundaries with the internal space being freely ventilated from the sides. Internal girders provide the stiffening strength to enable the deck to span the cargo and ballast tanks and support the process plant above.

6 The specific arrangement of the six primary functional blocks 1, 5, 6, 7, 35 and 36 allows that the primary normally manned areas 5 and 7 be interfaced and also directly interfaced:

- with 6 which is directly interfaced with the lifesaving equipment 35 and 36 and
- with 1, which is achieved by having vertical access in both 5 and 7 up to 1.

7 As previous oil production ships and proposed designs have had the primary functions split over more than one structural boundary, advantages of the design invention are:

- The simplification of the interface between blocks, which is a major part of the initial design of any such floating production system
- The functional blocks separate the different marine and offshore regulatory areas so the conflicting requirements between regulatory requirements are minimised
- The ability to have functional blocks specified, designed and even constructed before other blocks are at the same stage of development, so that the blocks with the longest total construction time can be identified and started before other blocks, e.g. one would probably have to complete the design of and start constructing the accomodation block before a decision on the number of oil tanks and ultimately the length of the vessel is made
- The arrangement of the blocks enables the system to be put together and connected up with cables

and piping which accesses each block by passing through the minimum number of boundaries

- The arrangement of the blocks enables the system to be operated and accessed by personnel by passing through the minimum number of boundaries because of the access ways 18 and the close positioning of the blocks 5 and 7
- The arrangement of the normally manned blocks 5 and 7 provides for the minimum distance to the methods of evacuating the vessel 1, 35 and 36 via the muster station 6
- The main variables of Storage Volume, Process Plant Area and Accommodation Requirement can be varied in the initial stages of the building (up to 6-9 months before delivery).
- The Design allows any Safety Case requirements to be fully analyzed before commitment to finalising any of the main parameters. This is very important since the obtaining of Government approval for one block need not delay the detailed design and building of other blocks
- For most applications (excluding arctic requirements), the Classification of the vessel need not be decided before the storage requirement has been confirmed (up to 9-12 months before delivery.
- The hull/turret configuration incorporates all requirements for a worldwide mooring location,

including disconnectable systems in Typhoon areas.

- The subsea interface has been addressed by incorporating three options for the turret assembly:
  - up to 6 riser bundles without work-over;
  - up to 10 riser bundles and work-over;
  - up to 6 risers and disconnectable without work-over.
- The hull can be modified and extended for future developments. Thus even after the vessel has been in use for several years it may be desirable and it is possible to modify the oil storage and/or oil processing blocks to suit the requirements of a different field, whilst still retaining the block forward of the turret unchanged.
- The turret functional block allows a completely different subsea interface requirement to be met by exchanging the turret assembly.

CLAIMS

1 An oil production ship, vessel or barge comprising a hull moored by an internal turret which is forward of the centre of environmental forces near the amidships, so that the vessel may weathervane, the portion of the vessel forward of the turret containing all the enclosed and mechanically ventilated areas, which have personnel present without protective clothing being necessary, to operate the vessel in the same manner as a ship, all the systems containing hydrocarbons and hazardous areas being placed in, or aft, or behind the turret.

2 An oil production ship, vessel or barge as claimed in Claim 1, in which each of the primary functional blocks may be described, specified, designed, engineered and constructed within pre-defined structural boundaries which will form the necessary boundaries between the functions to meet the regulations and requirements for operating the vessel.

3 An oil production ship, vessel or barge as claimed in Claim 1 or Claim 2, in which the top and bottom of the main deck sandwich structure (21), are steel boundaries with the internal space being freely ventilated from the sides. Internal girders provide the stiffening strength to enable the deck to span the cargo and ballast tanks, and support the process plant above, as well as contributing to the longitudinal strength of the hull.

4 An oil production ship, vessel or barge as claimed in Claim 1 or Claim 2 in which the Helicopter Facilities (1),

Hotel Services or Accommodation Block (5), Evacuation Muster Station or Safe Refuge (6), Operational Control Centre (7), Forward Starboard Lifesaving Apparatus (35) and forward Port Lifesaving Apparatus (36) shown in Figures 1-7 are arranged such that (5) and (7) are directly interfaced, and also directly interfaced:

- with (6), which is directly interfaced with (35) and (36).
- with (1), which is achieved by having vertical access in both (5) and (7) up to (1).

5 An oil production ship, vessel or barge substantially as described herein with reference to Figures 1-8 of the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	17	Application number GB 9303391.8
Relevant Technical Fields (i) UK Cl (Ed.M) B7A (A430, AAQ); B7V (VFA) (ii) Int Cl (Ed.5) B63B 35/00, 35/44		Search Examiner A HABBIJAM Date of completion of Search 13 APRIL 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASES: WPI		Documents considered relevant following a search in respect of Claims :- 1-5

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Category	Identity of document and relevant passages		Relevant to claim(s)
A	GB 981016	(PHS VAN OMM EREN)	1
A	GB 799556	(STAFFANSSON)	1
A	WO 85/03048 A1	(WUTTUDAL)	1

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